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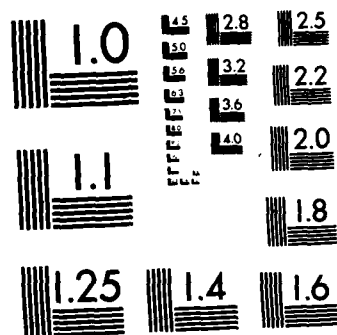
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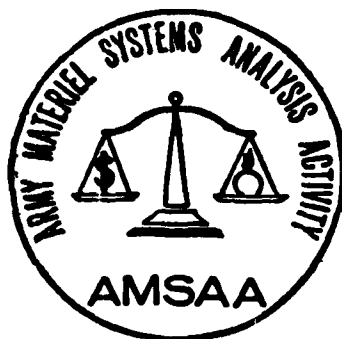
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PROJECT NUMBER 046

FINAL REPORT

BULK RELOCATION OF ATTRITION STOCKS;
ECONOMIC CONSIDERATIONS

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U. S. ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY
LOGISTICS STUDIES OFFICE
FORT LEE, VIRGINIA 23801

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The word "he" is intended to include both the masculine and feminine genders; any exception to this will be so noted.

PEER REVIEW

This report has been conscientiously reviewed by Messrs. Edward F. Glavan, Operations Research Analyst, and Peter J. Higgins, Logistics Management Specialist.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Attrition Stock; Storage Costs; Transportation Costs; Logistical Reassignment.		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A consolidated massive quantity of secondary items may become a candidate for storage relocation for a variety of reasons, including mission changes, redistribution of assets, or transfer of logistics responsibility. DODI 4140.49 was issued to insure that economic ramifications are explicitly considered in such a relocation decision. It prescribes an admittedly "conceptual" economic breakpoint formula to compare the costs of bulk relocation versus attrition. This study investigates the breakpoint formula published in the DODI to insure its effective and efficient implementation within the Army. (continued)		

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20. (continued)

It was concluded that this algebraic formula cannot adequately represent the unique characteristics of each mass relocation circumstance. A comprehensive economic analysis approach is recommended that complies with the basic intent of the DODI. This economic analysis must be centrally directed and evaluated by HQ DARCOM. The results can then be incorporated into the multi-attribute decision process with such competing factors as readiness, reaction time, facilities, and vulnerability.

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BULK RELOCATION OF ATTRITION STOCKS;
ECONOMIC CONSIDERATIONS

LOGISTICS STUDIES OFFICE
PROJECT NUMBER 046

FINAL REPORT
JUNE 1983

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JOSEPH R. BAINBRIDGE

LOGISTICS STUDIES OFFICE
US ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY
FORT LEE, VIRGINIA 23801

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EXECUTIVE SUMMARY

A consolidated massive quantity of secondary items may become a candidate for storage relocation for a variety of reasons, including mission changes, redistribution of assets, or transfer of logistics responsibility. DODI 4140.49 was issued to insure that economic ramifications are explicitly considered in such a relocation decision. It prescribes an admittedly "conceptual" economic breakpoint formula to compare the costs of bulk relocation versus attrition. This study investigates the breakpoint formula published in the DODI to insure its effective and efficient implementation within the Army.

The basic principles underlying the DODI guidance are irrefutable; however, the breakpoint formula is fundamentally invalid and operationally unsound in the Army context. This algebraic formula cannot adequately represent the unique characteristics of each mass relocation circumstance. A comprehensive economic analysis approach is recommended that complies with the basic intent of the DODI. This economic analysis must be centrally directed and evaluated by HQ DARCOM. The results can then be incorporated into the multi-attribute decision process with such competing factors as readiness, reaction time, facilities, and vulnerability.

I. INTRODUCTION

A. Background.

The Army is sometimes confronted with the situation of having materiel in storage at nonpreferred locations. This occurs despite comprehensive procedural documentation and conscientious materiel managers. For example, materiel may be judged to be improperly located due to changes in management responsibility or shifts in user demand patterns.

If materiel is deemed to be stored at an improper or unpreferred location, there are basically two feasible options available. The first option is to retain the stock there and either gradually deplete it by issuing it without replacement or dispose of it when/ if it becomes excess. In this first option, which can be considered the status quo, the depletion process is called attrition, the improper storage location is designated as an attrition site, and the improperly located items are referred to as attrition stocks. The second option, which can be considered an alternative to the status quo, is to relocate the attrition stock to a desired location.

In terms of the amount of attrition stock involved, the decision to attrite versus relocate is affected by a broad spectrum of situations. If, for example, the situation involves only small quantities of one or several erroneously positioned items, relocation is generally not a viable option. Here, the appropriate item manager(s) can quickly attrite them through the requisitioning process. On the other end of the spectrum, a transfer of

management responsibility (i.e., logistical reassignment) or a large shift in user demand pattern can result in massive quantities of varied attrition stocks. As the quantity and variety of items increase, so do the strategic and economic implications. When large quantities of varied materiel located at the same facility are candidates for relocation, the decision should not be made on an item by item basis. Opportunities for significant cost savings/avoidance may exist in this situation. Thus, guidance for mass interdepot movement of stocks should be provided by a central organization having overall visibility of the Army's requirements.

The predicament of massive attrition stocks is particularly acute in the Defense Logistics Agency (DLA). Throughout their history, they have been repeatedly confronted with the decision of whether to bulk ship materiel to a more desirable depot or use attrition to gradually deplete the current storage location. A General Accounting Office (GAO) report (January 1974) questioned the criteria being used to determine bulk movement of materiel from attrition sites in DLA.

As stated in the GAO report, this questionable DLA guidance permitted "a supply center to bulk move any residual nonexcess stocks of less than 75 tons from an attrition site when the move will evacuate all stocks of that commodity from the site." In 1974, DLA studied the guidance they were using to make relocation decisions. The study recognized that supply effectiveness and shipment consolidation were adversely impacted by multiple stock locations. The study proposed use of a breakpoint formula

for comparing estimated costs associated with attrition procedures to the cost of bulk transferring the stock to the primary location. This concept of minimizing cost was appealing and easily understood, however, assigning values to the variables influencing the cost calculations proved to be difficult.

This early attempt to provide bulk relocation guidance recognized the need to be flexible to accommodate additional factors. It also acknowledged that assumptions and compromises may be necessary to permit a timely decision.

Formal response to the DLA study by the Army, Navy, and Air Force was uniformly skeptical and challenged the methodology, validity, and workability of the proposed breakpoint formula. Efforts were then made to refine the formula.

In March of 1981, Department of Defense Instruction (DODI) 4140.49, "Movement of Stocks from Attrition Sites," incorporated a more complex version of the DLA breakpoint formula. It is intended to assist the decision making process when managers are confronted with an attrite versus bulk relocate dilemma. The services still harbor reservations about applying the DODI formula as reflected in their staffing comments. However, each service has implemented the DODI in their respective materiel management documentation.

DARCOM is the organization responsible for materiel storage positioning policy in the Army. In 1981 the Materiel Readiness Support Activity (MRSA) was tasked with incorporating the DODI information into appropriate Army regulations. Also, the Automated

Logistics Management Systems Activity (ALMSA) was asked to implement the attrition guidance into the Commodity Command Standard System (CCSS). ALMSA replied that this could not be done until DA or DARCOM policy was available concerning the identification and sources of data involved. Subsequently, their tasking was suspended until completion of a study.

The Supply and Distribution Management Division, Directorate for Supply, Maintenance, & Transportation, HQ DARCOM, has sponsored AMSAA in this study to determine implementation procedures for management of attrition stocks. The Logistics Studies Office, AMSAA, performed this analysis in the spring of 1983. This report is the result of that analysis.

B. Authority for the Study.

The DOD attrition stock management guidance needed to be scrutinized in more detail before it could be adapted to Army management systems. In late November 1982 the Chief, Supply and Distribution Management Division, HQ DARCOM, requested that AMSAA perform a systems analysis of the contents of DODI 4140.49. Specifically, the breakpoint formula, its applicability to Army circumstances, and the impact of implementing it needed to be assessed. The Director of Management, DARCOM, elucidated the requirement to evaluate the applicability of DODI 4140.49 to the wholesale supply system, including required modifications to the CCSS.

Essentially, the question, "Where in the Army Logistics System must the DOD guidance be utilized and how can it improve effectiveness

and/or efficiency?," must be answered. The validity and appropriateness of the formula and related variables must also be determined.

C. Study Definition.

The purpose of this study is to insure that DODI 4140.49 is effectively and efficiently implemented within the Army. By evaluating the Army's need for modified/enhanced attrition stock management guidance, Army managers can be provided the information necessary to proceed from the DODI guidance to material decisions that accomplish the intent of its contents.

Specifically, this study begins with a background discussion of attrition management policies/procedures/events leading up to the DODI. Then the DODI and its economic breakpoint formula are analyzed, emphasizing mathematical validity and managerial practicality. Modifications or enhancements are proposed to increase the effectiveness of the economic analysis approach directed by the DODI. Data availability and pertinent cost factors are addressed. The organizational element or system in which the economic analysis should be operative is identified. Implementation guidance/procedures are developed and the potential impacts are assessed.

The scope of the study is limited to the DARCOM wholesale supply system, excluding intermediate level supply systems. This study is limited to secondary items, whereby, bulk quantities of varied materials are addressed with no specific commodity differentiations. This study recommends procedures to optimize the application of the information in the DODI, but does not attempt to

execute or simulate implementation. Formal modeling and computer simulations were not utilized. Redesign of the Army distribution system is not considered. It is assumed that for decision guidance to be implementable, it must be straightforward and relatively simple. Ultimate accuracy at the cost of unwieldy complexity is avoided.

The information contained in this report was obtained through personal interviews, telephone interviews, and intensive literature research and analysis.

II. ANALYSIS AND DISCUSSION

A. Evolution of DODI 4140.49. Background research was conducted to clarify the scope of the problem and to insure that the study effort was oriented properly. A search of literature and discussions with the developers of the DODI/breakpoint formula uncovered the following chain of events leading to the current DODI 4140.49.

1. As DSA (renamed DLA) evolved in the 1960s and 1970s, it assumed management responsibility via logistical reassignment for large quantities of materiel physically located at military service storage locations (termed attrition sites). DLA was (and still is) confronted with a choice of relocating these stocks to a DLA depot or to issue (attrite) them from their current non-DLA location. DSA guidance (DSAR 4145.5, DSA Materiel Distribution System, 14 Oct 69) prohibited bulk relocation without HQ DSA approval; unless a shipment of less than 75 short tons would vacate all non-excess attrition stock from the site. Thus, when an attrition site was not vacated of attrition stock by a bulk move of less than 75 short tons, logistically reassigned stocks were depleted through normal search patterns for filling requisitions. DOD guidance (DOD Directive 4140.26, Integrated Materiel Management of Consumable Items, 26 Feb 72) directed that these logistically reassigned stocks be issued or disposed of in place unless it is necessary or economical to relocate them.

2. GAO Report B-146828, "Improvements Needed in Management of Items Transferred from the Army to the Defense Supply Agency," 3 Jan 74, was critical of DLA's policy regarding attrition

stocks. This audit recommended that the "Secretary of Defense direct that the criteria used to support decisions to move items transferred for management from the losing service to the storage sites under control of the gaining inventory manager be based on appropriate economic analysis."

3. In response to the GAO audit, the Deputy Assistant Secretary of Defense (Supply Maintenance & Services) issued a 12 Jun 74 memorandum requesting that DSA use appropriate economic analysis when deciding whether to attrite in place or bulk relocate materiel that has been transferred to their responsibility. DSA responded with a "Study Report on Bulk Movement of Materiel from Attrition Sites," dated December 1974. This report recognized that multiple stock locations adversely affected supply effectiveness by reducing on-time fill rates, increasing warehouse denial rates, creating duplicative inventory costs, decreasing asset visibility, and reducing opportunities for shipment consolidations. Most significantly, the report proposed the following breakpoint equation that recommends relocation only if the cost of bulk relocation is less than the cost of remaining in storage at the attrition site. In algebraic notation, bulk relocate if:

$$C_t + [(C_s + C_r) \times N] \leq C_o \times N,$$

where:

C_t = Bulk transportation cost from the attrition site to the nearest DLA depot with stockage responsibility,

C_s = Shipping cost (pick, pack, make ready) per line item,

C_r = Receiving cost (receive, put away) per line item,

N = Number of line items at attrition site, and

C_0 = Annual operating cost to maintain one line item at the attrition site.

This equation was intentionally designed to be practical and free of complicated data requirements. It was tested in the report and determined to be compatible with available DLA data.

4. The Deputy Assistant Secretary of Defense (Supply, Maintenance, & Services) staffed the DLA report with the Assistant Secretaries of the Military Services (I&L). Responses were uniformly skeptical and challenged the methodology, validity, and workability of the proposed breakpoint formula. Selected comments are as follows:

a. The Army recommended, among other things, a need to consider: (1) the difference in shipping cost of attrition site to the customer versus relocation site to the customer; (2) the cost to hold the stock at the relocation depot; and (3) rather than annual storage cost, a weighted average should be used based on time required to attrite the stock.

b. The Navy recommended consideration of: (1) the relative costs to ship materiel to the customer, and (2) the differential holding costs between the attrition site and the relocation depot. The Navy commented that "even in its simplistic form, some of the data required to provide the factors can be complicated depending on the degree of precision desired."

c. The Air Force stressed the need to consider the operating cost at the relocation depot, not just the attrition site. The Air Force also stressed that "... a meaningful assessment of the true costs of retaining storage at attrition sites would have to assign

dollar values to somewhat intangible costs which may prove to be difficult."

5. DLA reviewed the Military Service comments to their study and in conjunction with DOD prepared DODI 4140.49 which incorporated several of the previous comments into a revised breakpoint formula. Although DLA and the Military Services all agreed that a simple formula with gross approximations would be desirable, the resultant formula was more sophisticated than the original. The Army concurred only after being given assurance that: (a) it applies only to integrated management materiel, (b) it will not impede individual item redistribution, and (c) it applies to ranges of items to be transferred in bulk. The Navy stressed in their implementing guidance that the goal of minimizing cost is secondary to the primary goal of supply responsiveness. The Air Force proposed that the breakpoint formula be applied only when the new stockage location is a superior distribution point. The Air Force also expressed concern that the differential cost of storage is not readily obtainable.

B. Current Implementation of DODI 4140.49. Despite severe misgivings by the Military Services, the DODI 4140.49 became effective 17 March 1981 and was forwarded for implementation. All three services and DLA have officially implemented this guidance as described below.

1. The US Army DARCOM Materiel Readiness Support Activity (MRSA) incorporated the economic breakpoint formula into AR 725-50, titled "Requisition and Issue of Supplies and Equipment, Requisitioning, Receipt, and Issue System," through Change 2, dated May 1982,

to the basic AR. The change placed the formula verbatim into paragraph 5-59g of Section VII, Logistical Reassignments. In addition, paragraph 8 of DARCOM-R 740-4, Storage and Supply Activities; Stock Distribution, references the paragraph 5-59g of AR 725-50.

2. The Navy incorporated implementing guidance into NAVSUPINST 4440.161A, SUP0422F, Policy for Distribution of Navy Inventory Control Point Owned and Managed Stocks, dated 20 May 1982. Enclosure 9 to the Instruction references DODI 4140.49 and reproduces essentially the entire DODI with a few minor word changes. Paragraph 4, Discussion, of the Instruction stresses that the primary goal of materiel distribution in a military supply system is to be responsive to customer demands with a secondary goal of cost minimization. It then refers to its enclosure 9 as a procedure for reaching cost effective decisions on retention or movement of materiel located at attrition sites.

3. The Air Force inserted several consecutive sentences into section C, Logistic Reassignment, of Vol 1, Part Two, 30 Mar 81, of AFM 61-1, US Air Force Supply Manual. Here it is directed that prior to relocation decisions, a cost effectiveness analysis will be conducted in accordance with DODI 4140.49. It is explained that this decision must be based on the relative costs of moving the stocks versus the cost of storing and managing the stocks at the attrition site.

4. DLA has taken the most aggressive approach to implementing the DODI 4140.49. They have established DLA Regulation 4140.65,

14 Oct 82, Movement of Stocks from Attrition Sites. This two-page document delineates policy and responsibilities tailored to the DLA organizational structure and references the formula in DODI 4140.49. In addition, they are currently attempting to automate the breakpoint formula. HQ DLA has tasked an ORSA cell at the Defense General Supply Center (DGSC), Richmond, VA, to develop procedures to estimate the cost parameters in the breakpoint formula. At the time of this report, draft procedures with computer coding are being staffed for comment. HQ DLA approval has not been received nor has a schedule been set for testing or implementing the breakpoint formula.

C. Analysis of DODI 4140.49 Breakpoint Formula. DODI 4140.49 delineates DOD policy for making cost-effective decisions when materiel is located at attrition sites. The intent of this document is to insure "cost-effective" decisions regarding bulk relocation of attrition stocks. Stated policy is to "minimize total operating costs of maintaining stock at identified attrition sites against movement to a DOD Component depot or storage site." To assist in making this retain/ relocate decision the following "conceptual" formula is prescribed in the DODI as the "economic decision criterion":

$$C_t + A (C_r + C_s) < \sum_{i=1}^N \sum_{k=1}^{S_i/D_i} \frac{C_o}{(1+j)^{k-.5}},$$

where:

C_t = bulk transportation cost,

C_s = shipping cost per line item (or per ton),

C_r = receiving cost per line item (or per ton),

A = number of line items (or number of tons) of attrition stock,

C_0 = added annual operating cost to maintain a line item at the attrition site,

S_i = stock on hand of item i at the attrition site,

D_i = annual forecasted demand of item i ,

N = number of line items,

i = line item subscript,

j = discount rate, and

k = (up to and including) year in which stock is depleted.

The DODI further defines " C_0 " as the differential cost of maintaining a line item at duplicate locations. This concept assumes that it costs more to store an item at two locations rather than one. The following factors are then listed in the DODI to be considered when calculating C_0 :

- o cost of taking physical inventories
- o cost of ICP depot location files
- o cost of duplicate locator systems
- o cost of duplicate bin issue locations
- o costs due to loss of space consolidation
- o costs due to loss of freight consolidation
- o cost of shelf-life surveys
- o the differential in estimated second destination transportation costs (may be positive, negative, or zero)
- o the differential between costs of commercial storage sites or commercial versus DOD storage sites
- o other additional costs at ICP or storage locations.

Essentially, the left side of the inequality addresses bulk relocation costs, while the right side addresses the cost of

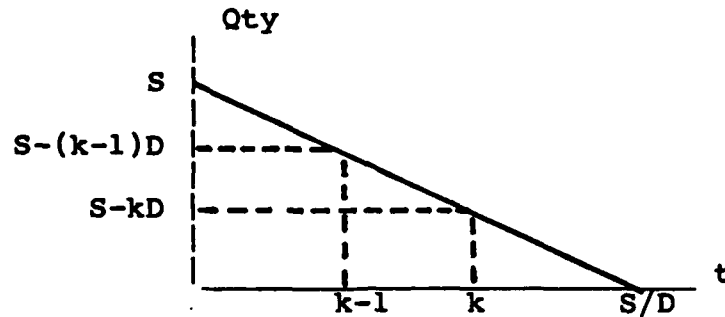
retention (attrition). The left side includes costs to ship (pick, pack, make ready), bulk transport, and receive (receive and put away) the attrition stocks. The specific form of the left side can be easily modified to fit the level of detail of the available data. For example, if the shipping and receiving costs are dependent on the specific line item, the left side could look like:

$$C_t + \sum_{i=1}^N (C_{ri} + C_{si})$$

However, the important point is that these categories of cost (ship, bulk transport, receive) on the left side of the inequality are readily available and are consistent with the Army accounting structure.

On the other hand, the right side of the equation poses serious shortcomings. It assumes that you can calculate a differential operating cost, " C_o ," that is constant over all line items and constant over time. This operating cost is then discounted over the attrition life ($k_i = 1$, S_i/D_i) of each item and then aggregated over all line items. Some flaws with this approach are as follows:

1. First of all, those elements of " C_o " associated with physical storage are not constant over time, but rather they decrease as the stock (S) is depleted. For example, assuming constant demand (D) expressed in quantity per time period, the quantity (and cost) of items in storage gradually goes to zero as shown in the figure below. This phenomenon could be incorporated into the formula as a multiplicative factor applied to C_o , namely $C_o[S - (k_i - 1/2)D]$.



$$\text{avg stock} = \frac{[S-(k-1)D] + [S-kD]}{2} = \underline{\underline{S-(k-1/2)D}} \quad (k-1 \text{ to } k)$$

2. The operating cost may vary significantly by line item, which would further increase the complexity of the formula such that C_0 would become $C_{0i}[S_i-(K_i-1/2D_i)]$.

3. The differential second destination transportation costs are significant enough to warrant explicit calculation rather than being a subset of C_0 . Actually, these second destination transportation costs are complex and are functions of demand patterns and response times of the depots, among other things.

4. The elements of C_0 are not compatible with the data available within the Army accounting structure. For example, the Army does not track costs of depot location files, or location systems, or space/freight consolidation savings.

5. There are too many incommensurable costs buried in " C_0 ," some negligible (i.e., depot location files) and some significant and complex (i.e., second destination transportation costs). Rather than modify the formula to accommodate the military service comments, the original formula was retained by adding new cost elements to C_0 . The result is that the right hand side of the formula is simple but operationally invalid.

6. The concept of C_0 being the differential cost of maintaining stock at more than one location is theoretically appealing. However, it is virtually impossible to calculate. The Army captures various storage costs and transportation costs by individual depot with no consideration for differential costs. No published literature was found that endeavored to isolate the storage differential cost or the cost associated with increasing the number of storage sites while keeping a constant quantity of stock. There were only a few articles that addressed calculation algorithms of inventory holding costs, of which storage cost is a subset.

7. The incremental approach of summing up various elements to calculate C_0 has a serious drawback. These elements must be mutually exclusive and relatively exhaustive. Therefore, if a significant cost element is overlooked (i.e., effects of depot capacity, utility costs, manpower costs, etc.), then C_0 will be understated.

8. The right side of the formula, due to its format, gives primary visibility and emphasis to storage related costs. The preponderance of the literature, both inside and outside the government, state that storage costs are insignificant, approximating 1%-6% of the average inventory value. The difference between two relatively small costs would be even smaller and less significant. DODI 4140.39 suggests that storage cost is approximately 1% and "further studies to refine and update this rate do not appear warranted." However, the second destination transportation costs, which are much more significant, were added into C_0 as an after-thought due to a military service comment to the draft DLA report.

In summary, the decision formula is relatively straightforward except for the differential cost of operations. This one variable is very difficult to definitize and even more controversial to quantify. Since the decision is dependent upon this variable, application of the formula is inhibited. To be useful, a more comprehensive guide for determining this value is needed.

For the above reasons, the specific economic breakpoint formula is both fundamentally and practically unsound from an Army perspective. However, the DODI presents the formula as "conceptual" and encourages modification to fit specific problem situations. It recognizes that special situations may exist in which economic considerations may be overridden by more critical factors. The formula is a recommended approach to the attrition dilemma rather than a mandatory procedure. This flexibility is inferred by the DODI in the narrative explanations of the formula's variables. Research with the formula developers and the DODI proponent verified this intent.

It is crucial to note that the DODI breakpoint formula loses its appropriateness as the size (number of lines) and diversity of the materiel diminishes. The formula is not usable by item managers for relocation decisions for individual items.

Some questions have been posed concerning the low probability of circumstances arising in the Army that fit the definition of massive stock relocation. The Army has the Area Oriented Depot (AOD) concept in place which stipulates mandatory stockage points. Relatively little flexibility remains to reposition large quantities of stock.

D. Analysis of Current Army Implementation. AR 725-50, Chapter 5, Section VII, addresses Logistical Reassignments. Changes, published after DODI 4140.49 became effective, incorporated the breakpoint formula. Paragraph 5-59 of AR 725-50 instructs the Losing Item Manager (LIM) and the Gaining Item Manager (GIM) to work together toward strategically and economically acceptable relocation decisions. The LIM is told to use the breakpoint formula (from DODI 4140.49) semiannually as a decision making tool.

This implies that the data needed in the formula is available for individual lines and that the formula is valid for individual lines. However, as mentioned earlier in this report the formula must be applied to large quantities of varied materiel to function as designed. Furthermore, greater accuracy can be achieved by using an economic analysis approach (as opposed to a specific formula) while adhering to the principles in DODI 4140.49.

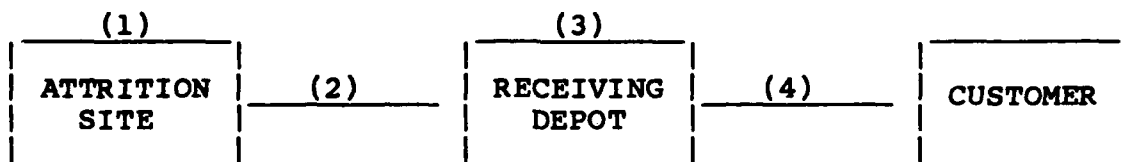
Decisions of the nature being addressed here must be made at HQ DARCOM and conveyed to the appropriate item managers for execution.

When an item manager has reason to believe that his/her items may be part of a large quantity of materiel being considered for relocation, inquiry must be made to HQ DARCOM. The Supply and Distribution Management Division (SDM) must be given an opportunity to issue special guidance before money is spent to relocate the materiel. The SDM Division should perform an economic analysis based on the intent of the DODI and integrate it with strategic/readiness considerations.

E. Recommended Approach.

The validity and propriety of the breakpoint formula as delineated in DODI 4140.49 is questionable in an Army context. The data requirements are not compatible with the Army Management Structure (AMS) of cost accounting. The incremental approach of calculating depot operating costs encourages omissions of important costs and the difference between the operating costs at the two locations would normally be very small. In light of the fact that Army circumstances leading to a massive logistic reassignment are remote and varied, a specific "formula" is not warranted. An economic analysis approach would be more appropriate, would minimize cost omissions, and could be tailored to meet the varied circumstances. However, to ensure consistency, the following guidance is recommended.

When faced with a relocate vs retain decision, the retain (attrite) alternative can be considered the status quo. In other words, it is only necessary to investigate the costs/savings incurred in relocating the stock. With this premise, the costs to relocate a massive quantity of stocks can be segregated into four categories as depicted in the figure and description below.



The first category includes all costs/savings related to the decrease in stocks at the attrition site. This includes direct and indirect storage cost components addressed in Program 7 - Central

Supply and Maintenance of the Army Management Structure (i.e., care of materiel in storage, rewarehousing, preservation and packaging, physical inventory, container assembly and manufacture, training, general storage support, inspection, overall supply depot support, ...), shelf life surveys, depot location files, etc. It also includes any ramifications associated with removal of a large quantity of stocks, such as warehouse closure, personnel reductions, utility reductions and changes in storage capacity. For all these cost components, it is important to differentiate between actual out-of-pocket costs/savings and opportunity costs/savings.

The second category captures the direct costs to transport the stock to the relocation depot. This includes shipping costs (pick, pack, make ready), bulk transportation costs, and receiving costs (receive and put away). These costs are readily available at MTMC. Obscure but significant costs can be attributed to deterioration/breakage during shipment, temporary (perhaps permanent) loss of accountability/visibility, and requisition denials of items not issuable during shipment.

The third category includes any costs/savings incurred at the receiving depot resulting from a massive influx of stocks. The types of costs/savings here are similar to those described in category one. Once again it is important to distinguish between actual and opportunity costs/savings.

The fourth category captures any cost differentials associated with shipment to the customer from the two storage locations

(i.e., attrition site versus relocation depot). Consideration here must be given to loss of freight consolidation, estimated second destination transportation charges, investment cost due to differences in order/ship time, depot automation, processing time, back shipments, requisition denials, requisition response times, etc. These are all functions of the capabilities of the two depots and the customer demand pattern.

It is imperative that such an economic analysis approach be directed by HQ DARCOM. That way, the attrition site and receiving depot can be provided consistent guidance and tasked to estimate their costs. The shipping, receiving, and transportation costs are obtainable from DESCOM with assistance from MTMC.

The primary advantage of the economic analysis approach is that it can be tailored to the particular aspects of the decision at hand. It does not lock the decision maker into an inflexible model that is incompatible with existing data and unable to accommodate all relevant costs. The cost categories delineated above capture all the factors addressed in DODI 4140.49, including the differential operating (storage) cost. It conforms with the intent of the DODI 4140.49 to address the economic implications of a stock relocation decision.

F. Proposed Modification of Current Army Implementation.

Logistical reassignments (discussed in Section VII of Chapter 5, AR 725-50) often create a desirability to relocate materiel in storage. Decision criteria include economics as well as strategic

needs and ultimate response time. Generally, this decision process takes the form of a trade-off between cost of relocation and the benefit of improved strategic positioning of stock, both constrained by such factors as facility limitations and materiel characteristics. Emergencies or force realignment may dictate stock relocation without consideration of the price tag.

Prior to initiation of an economic analysis, it must be established that relocating the stock is feasible. Conversely, the original site must be available for attrition management. The relocate/attrite decision should be based on a gathering of all costs to be incurred over time for both alternatives. This comparison will indicate which approach is least costly and when in the future the remaining stock should be relocated. The authority and capability to gather this data, interpret it, and provide policy based on it is centered in HQ DARCOM.

There are a vast number of factors that can influence these cost estimates. Each instance must be assessed to determine what specific costs/opportunities/benefits are affected by it. Essentially, the goal is to establish the costs of relocating the materiel and compare it to the costs of continuing to manage without an interdepot transfer of materiel. Special effort must be made to achieve true costs.

In light of the above decision environment, it is recommended that AR 725-50 be changed as follows. In the third sentence of Paragraph 5-59g delete "using the economic decision standard in Figure 5-1." Also, delete Figure 5-1. Add a Paragraph 5-59j to read:

"Stock will be moved to an existing site only when it is economically and operationally feasible to relocate stocks to a more effective and efficient storage site. If bulk quantities of stock are affected, a comprehensive economic analysis will be performed in accordance with the intent of DODI 4140.49, Movement of Stocks from Attrition Sites. (The conceptual formula discussed in the DODI, although not recommended, contains some pertinent variables for consideration.) This economic analysis will include all pertinent cost factors including (1) costs/savings due to a decrease in stocks at the attrition site, (2) costs to bulk transport stocks to the relocation depot, (3) costs/savings due to an increase in stocks at the relocation depot, and (4) cost differentials associated with shipment to the customer from the two storage locations (i.e., relocation site versus attrition site.) This analysis will be centrally performed by HQ DARCOM. Consult with the Supply and Distribution Management Division, Directorate for Supply, Maintenance, and Transportation, of HQ DARCOM for bulk relocation/attrition guidance."

III. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

A. Findings/Conclusions.

- o The DODI 4140.49 breakpoint formula is only valid when applied to bulk quantities of varied materiel.

- o The Army will seldom face a situation that fits the premise of the formula. DLA may need it periodically.

- o None of the Services unequivocally endorsed the DODI formula. All accommodated the requirement to officially implement the guidance.

- o None of the Services or DLA have utilized the breakpoint formula to make an attrition/relocation decision.

- o Logistical reassignments, Chapter 5 of AR 725-50, is the appropriate place for Army guidance; however, this guidance as currently written directs incorrect application of the breakpoint formula to individual line items rather than to bulk relocation for which it is designed.

- o A periodic review (i.e., 6 month interval) of all assets in storage to uncover bulk attrition stock is not necessary. Large quantities of mislocated materiel would result from a high level management decision and be apparent.

- o Depot cross leveling to reposition stock because of recent demand densities that varied from manager forecasts is not attrition. DODI 4140.49 is not appropriate for these decisions.

- o The basic formula reasoning is questionable, due partly to the way it evolved, forcing numerous dissimilar elements into "C₀" (i.e., the additional annual operating cost to maintain a line item at the attrition site). Also, the accuracy of the breakpoint

formula would be impacted by the necessity to estimate critical data elements.

- o The Army Management Structure (AMS) accounting system is not compatible with the derivation of "C₀" in the breakpoint formula.

- o The literature and interviewees unanimously agree that costs associated with transportation outweigh the differential storage costs/savings.

- o Published literature recognizes storage cost as a minor contributor to inventory holding cost. A differential treatment of storage cost would very likely yield a negligible cost.

B. Recommendations.

- o The DODI breakpoint formula is not appropriate for CCSS item decisions and should not be incorporated into CCSS.

- o When confronted with bulk relocation/attrition decisions, a tailored economic analysis approach should be taken. It should be performed by HQ DARCOM with support from subordinate commands.

- o AR 725-50 and DARCOM-R 740-4 should be revised as suggested in this report.

- o Army managers of materiel in attrition status should rely on the Supply, Maintenance, and Transportation Directorate of HQ DARCOM for special guidance.

- o DARCOM should request that DOD reevaluate/revise the contents of DODI 4140.49 considering this study and responses of the Services.

- o Further research to develop a sophisticated math model for attrition/relocation decisions is not warranted.

C. Specific Issues. The Supply and Distribution Management Division, DARCOM, requested recommendations for the following:

1. Values for variables required in the breakpoint formula.
2. System changes required to implement the DODI.
3. An assessment of the impact the implementation of the DODI will have on existing systems.

Based on the analysis performed by the Logistics Studies Office, AMSAA, responses to these specific requests are:

"1." The Army accounting system does not isolate the required data. Therefore, it is virtually impossible to obtain specific cost factors that are needed to achieve accurate representation of variables in the formula. If estimates or averages are used, the formula will be weakened beyond its already questionable validity.

"2." The DODI breakpoint formula should not be incorporated into Army computer systems. The infrequent anticipated usage and the need to modify considerations for each specific bulk attrition incident make manual application of an economic analysis desirable.

"3." Existing systems will not be impacted beyond responding to change in inventory positioning. The analysis of the attrition/relocation decision and subsequent direction should be outside of Army automated systems. Economic analysis of potential bulk relocations must be directed and evaluated at HQ DARCOM level.

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